Attorney Docket Number: FY.16653US0A
Applicant: Kishi
Title: METHOD FOR CONTROLLING MACHINE WITH CONTROL MODULE OPTIMIZED BY IMPROVED EVOLUTIONARY COMPUTING
Application Number: 09/873,510

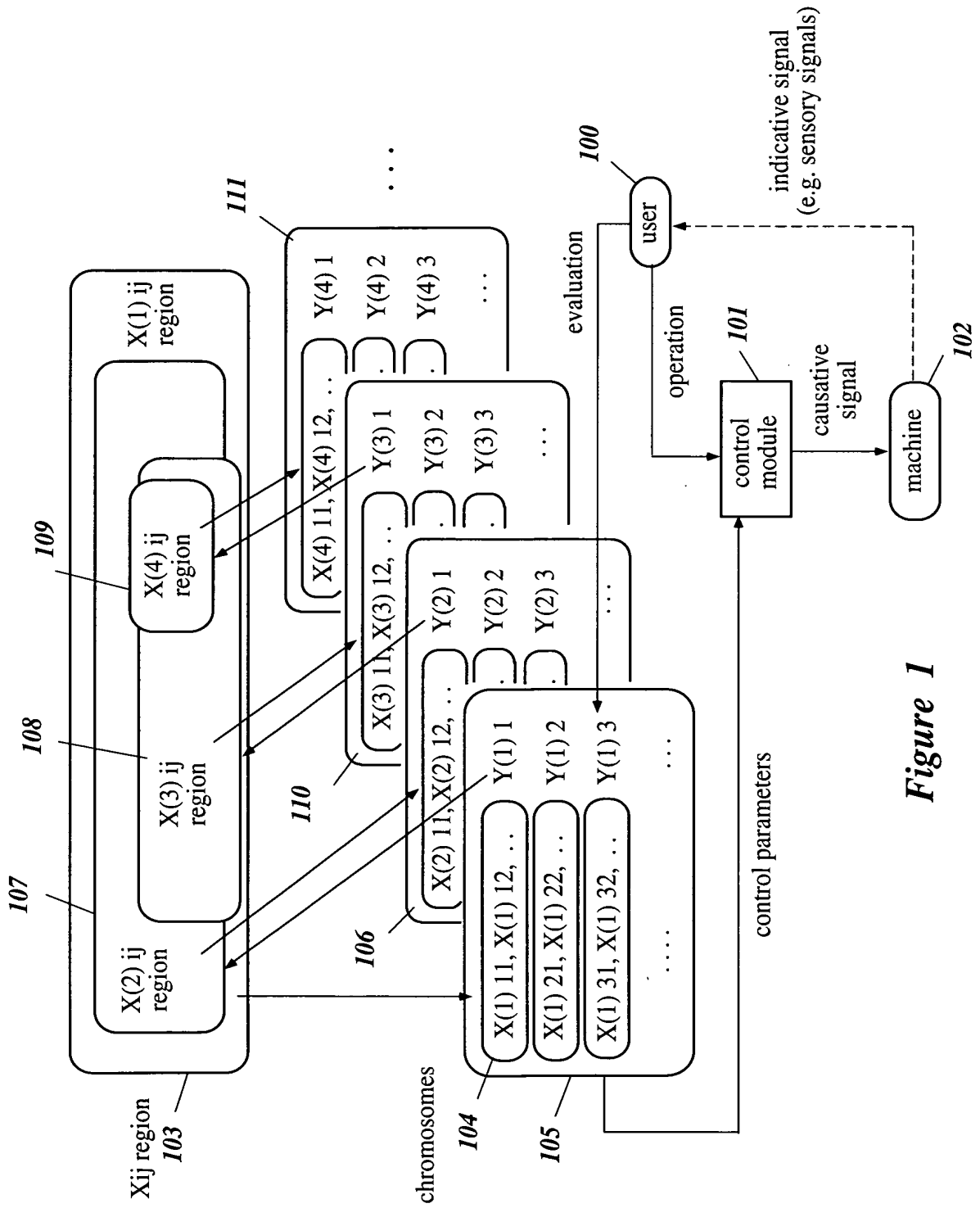


Figure 1

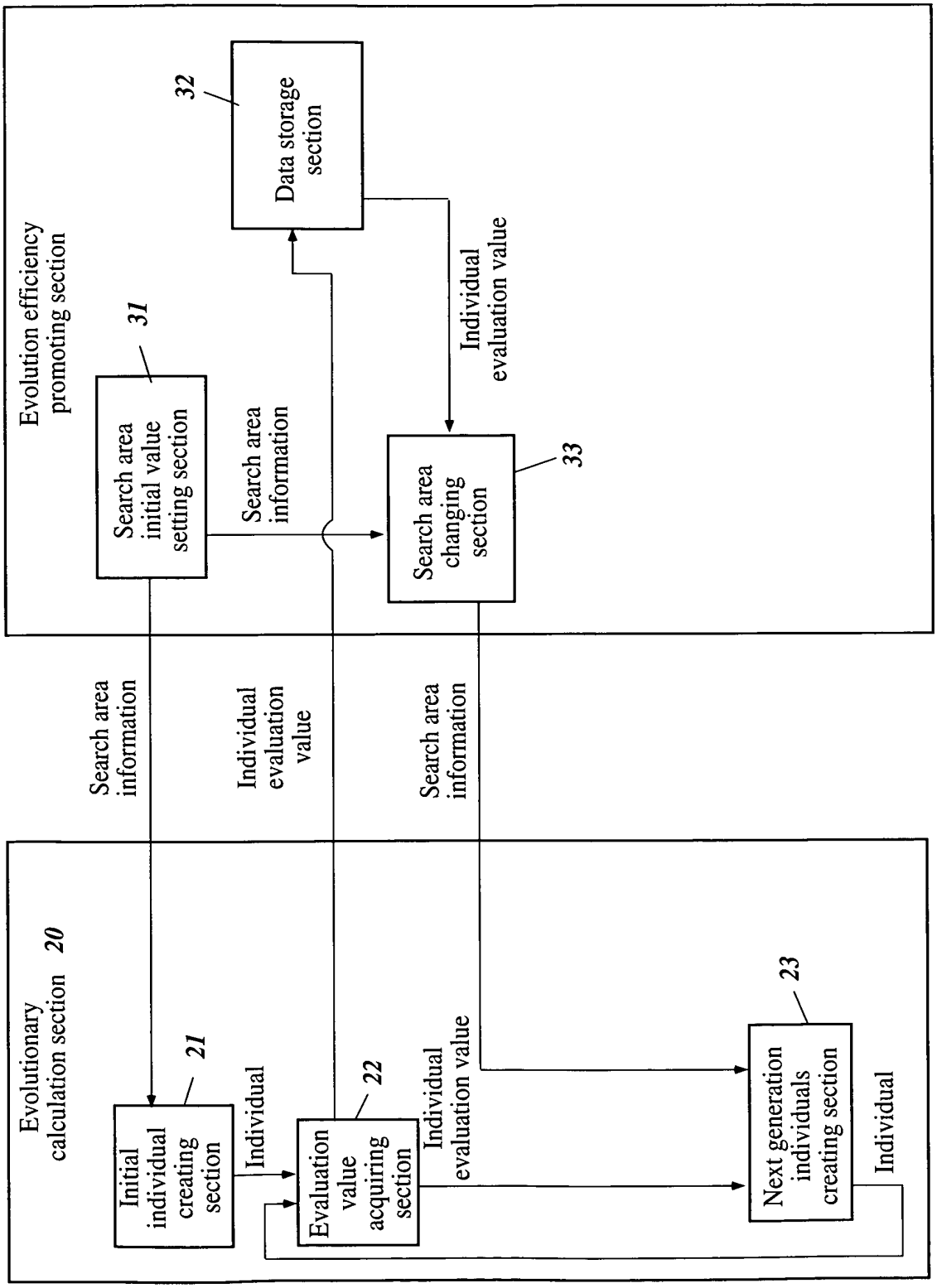

Evolution efficiency promoting section
32
Data storage section
31
Search area initial value setting section
Search area information
Individual evaluation value
Search area changing section
33
Search area information
Individual evaluation value
Search area information
Evolutionary calculation section
20
21
Initial individual creating section
Individual
22
Evaluation value acquiring section
Individual evaluation value
23
Next generation individuals creating section
Individual

Figure 2

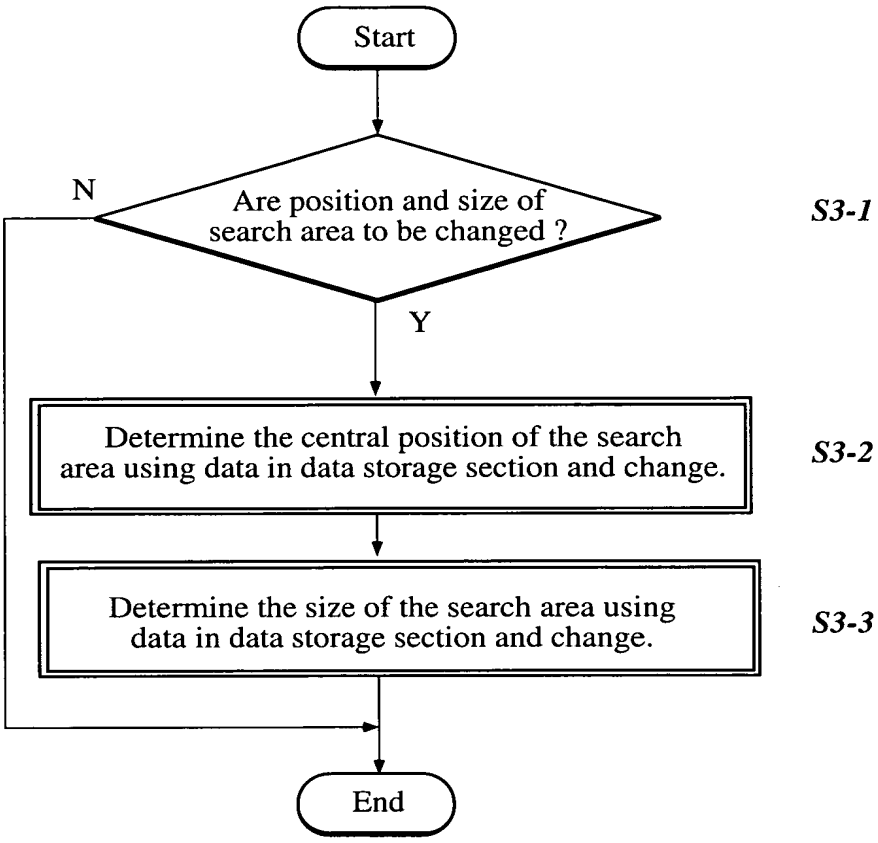

Start
Are position and size of search area to be changed ?
N
Y
S3-1
Determine the central position of the search area using data in data storage section and change.
S3-2
Determine the size of the search area using data in data storage section and change.
S3-3
End

Figure 3

① Change based on current size

Best evaluation value Y of i-th generation	Search area size (Amount of change in center-to-edge distance)	
	X_1 direction	X_2 direction
$0 \le Y < 20$	+20	+10
$20 \le Y < 40$	+10	+5
$40 \le Y < 70$	0	0
$70 \le Y < 100$	-10	-5

Figure 4A(a)

Figure 4A(b)

② Change irrespective of current size

Best evaluation value Y of i-th generation	Search area size (Amount of change in center-to-edge distance)	
	X_1 direction	X_2 direction
$0 \le Y < 20$	25	30
$20 \le Y < 40$	20	25
$40 \le Y < 70$	15	20
$70 \le Y < 100$	10	15

Figure 4B(a)

Figure 4B(b)

① Change based on current size

Shift distance (d) of search area center position	Search area size (Amount of change in center-to-edge distance)	
	X_1 direction	X_2 direction
$60 \leq d$	+20	+10
$40 \leq d < 60$	+10	+5
$20 \leq d < 40$	0	0
$0 \leq d < 20$	-10	-5

Figure 5A(a)

Figure 5A(b)

② Change irrespective of current size

Shift distance (d) of search area center position	Search area size (Amount of change in center-to-edge distance)	
	X_1 direction	X_2 direction
$60 \leq d$	25	30
$40 \leq d < 60$	20	25
$20 \leq d < 40$	15	20
$0 \leq d < 20$	10	15

Figure 5B(a)

Figure 5B(b)

① Change based on current size

Center position of next generation search area in current search area	Search area size (Amount of change in center-to-edge distance)	
	X_1 direction	X_2 direction
In area from 75% to 100%	+20	+10
In area from 50% to 75%	+10	+5
In area from 25% to 50%	0	0
In area from 0% to 25%	-10	-5

Figure 6A(a)

Figure 6A(b)

② Change irrespective of current size

Center position of next generation search area in current search area	Search area size (Amount of change in center-to-edge distance)	
	X_1 direction	X_2 direction
In area from 75% to 100%	25	30
In area from 50% to 75%	20	25
In area from 25% to 50%	15	20
In area from 0% to 25%	10	15

Figure 6B(a)

Figure 6B(b)

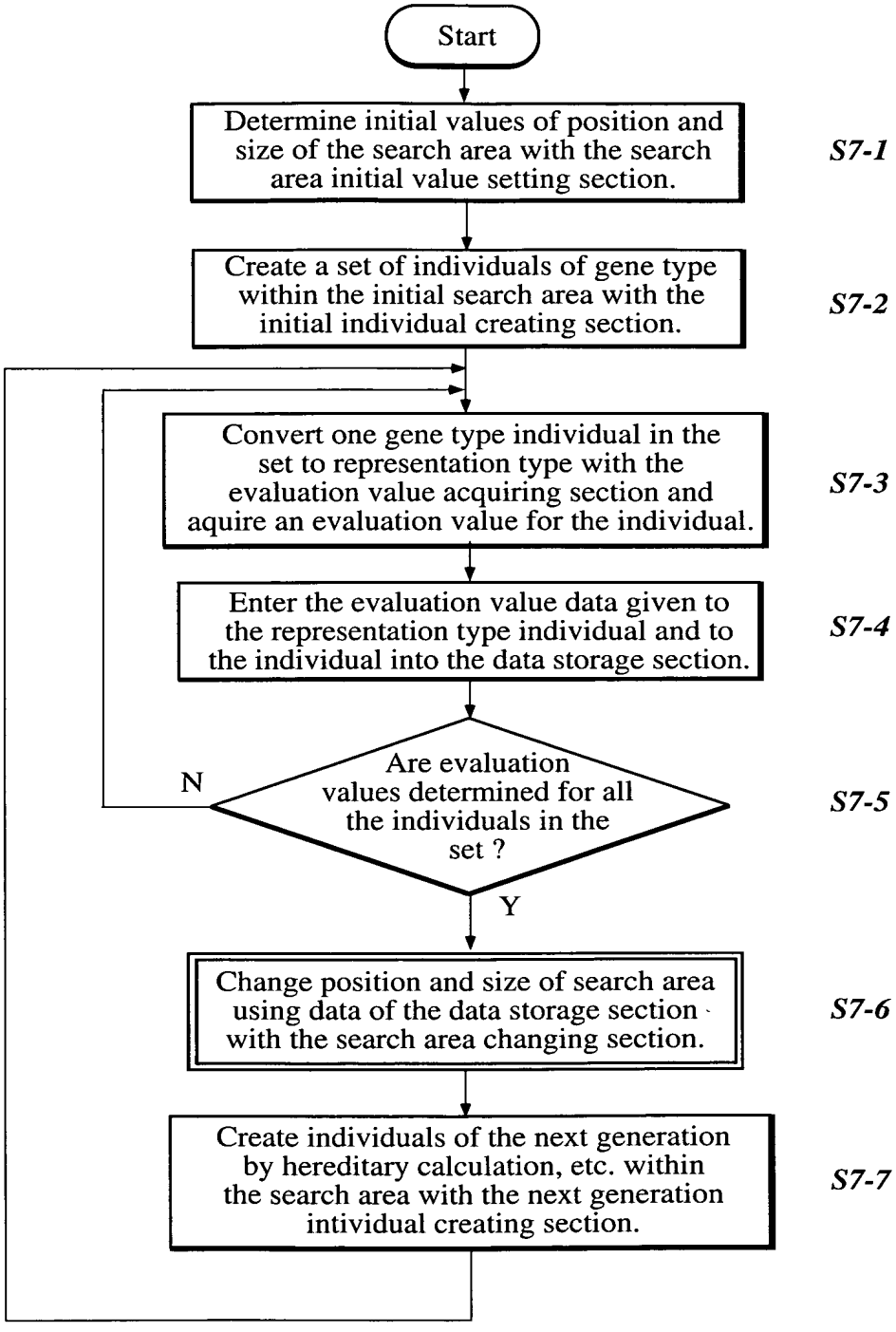

Start
Determine initial values of position and size of the search area with the search area initial value setting section.
S7-1
Create a set of individuals of gene type within the initial search area with the initial individual creating section.
S7-2
Convert one gene type individual in the set to representation type with the evaluation value acquiring section and aquire an evaluation value for the individual.
S7-3
Enter the evaluation value data given to the representation type individual and to the individual into the data storage section.
S7-4
Are evaluation values determined for all the individuals in the set ?
N
Y
S7-5
Change position and size of search area using data of the data storage section with the search area changing section.
S7-6
Create individuals of the next generation by hereditary calculation, etc. within the search area with the next generation intividual creating section.
S7-7

Figure 7

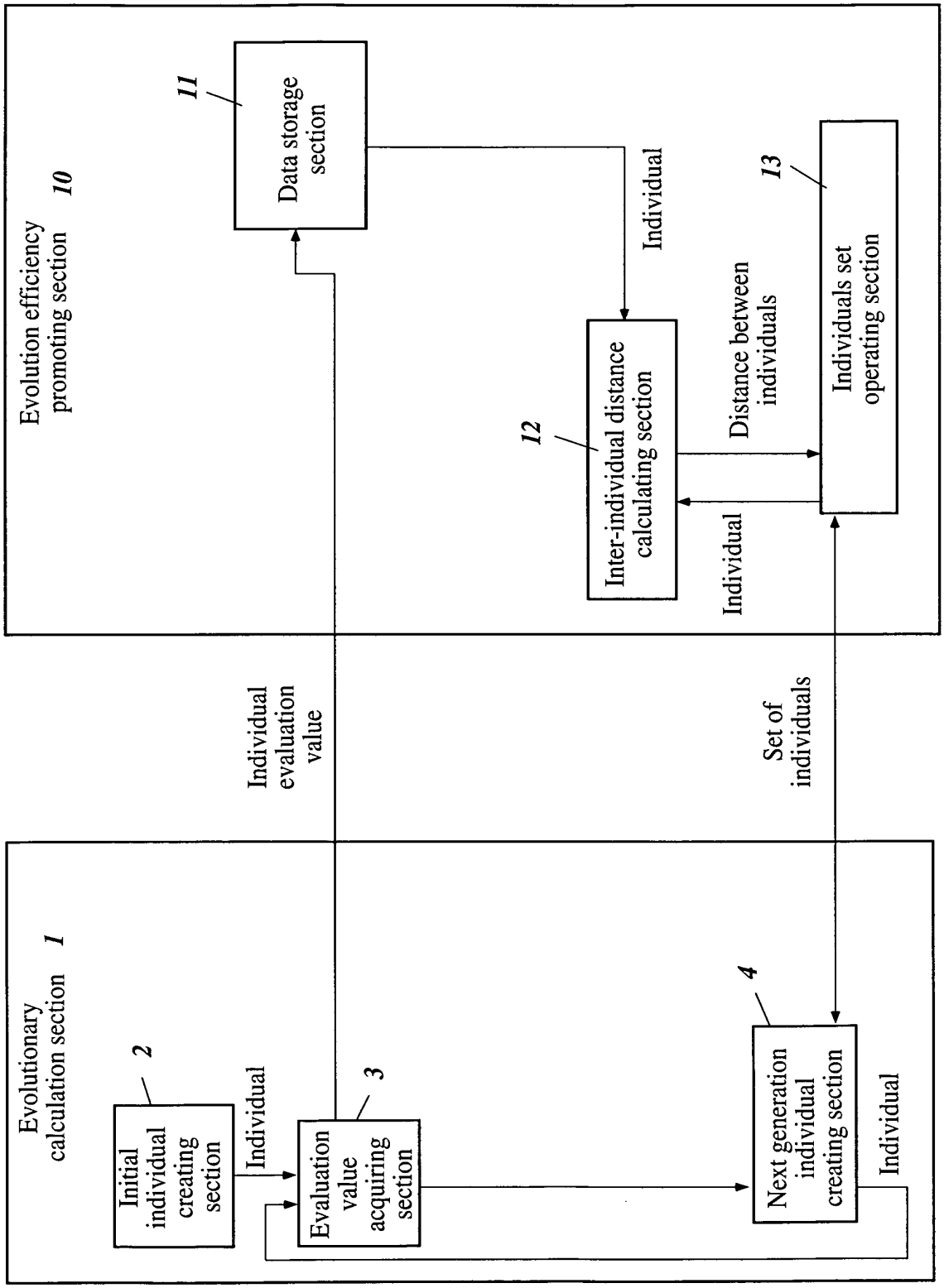

Evolutionary calculation section 1
Initial individual creating section 2
Individual
Evaluation value acquiring section 3
Individual evaluation value
Next generation individual creating section 4
Individual
Set of individuals
Evolution efficiency promoting section 10
Data storage section 11
Individual
Inter-individual distance calculating section 12
Distance between individuals
Individual
Individuals set operating section 13

Figure 8

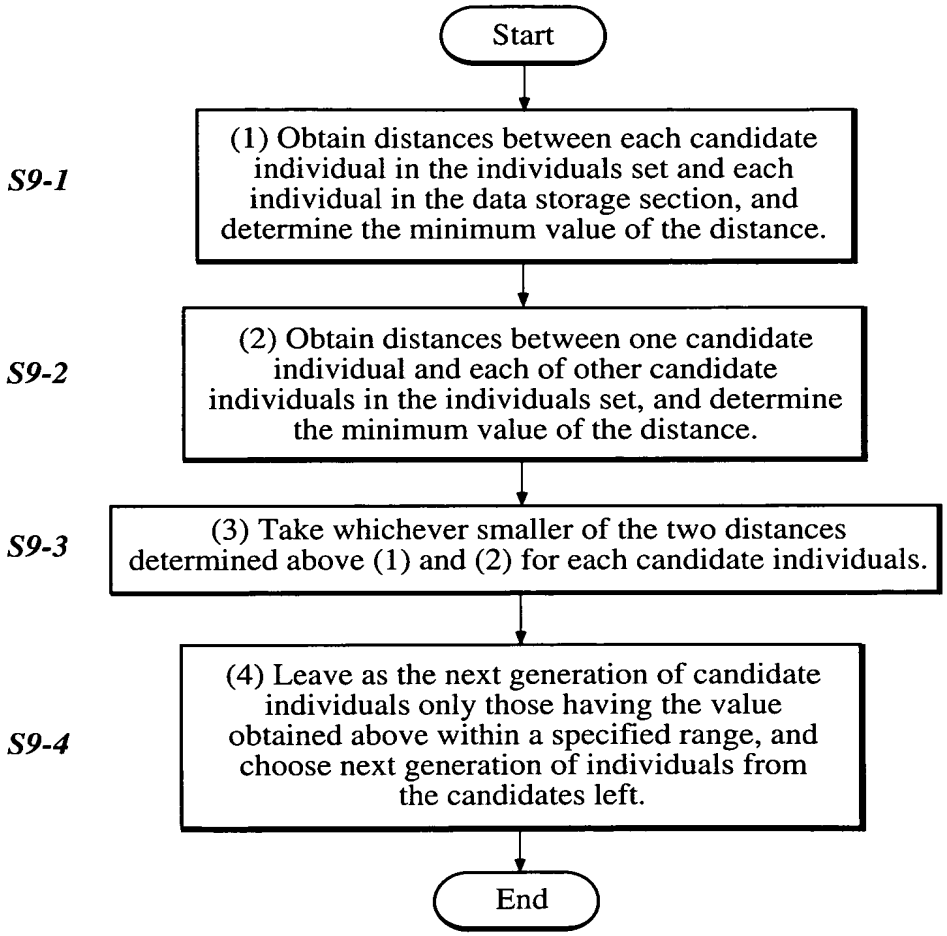

Start
S9-1
(1) Obtain distances between each candidate individual in the individuals set and each individual in the data storage section, and determine the minimum value of the distance.
S9-2
(2) Obtain distances between one candidate individual and each of other candidate individuals in the individuals set, and determine the minimum value of the distance.
S9-3
(3) Take whichever smaller of the two distances determined above (1) and (2) for each candidate individuals.
S9-4
(4) Leave as the next generation of candidate individuals only those having the value obtained above within a specified range, and choose next generation of individuals from the candidates left.
End

Figure 9

Figure 10(a)

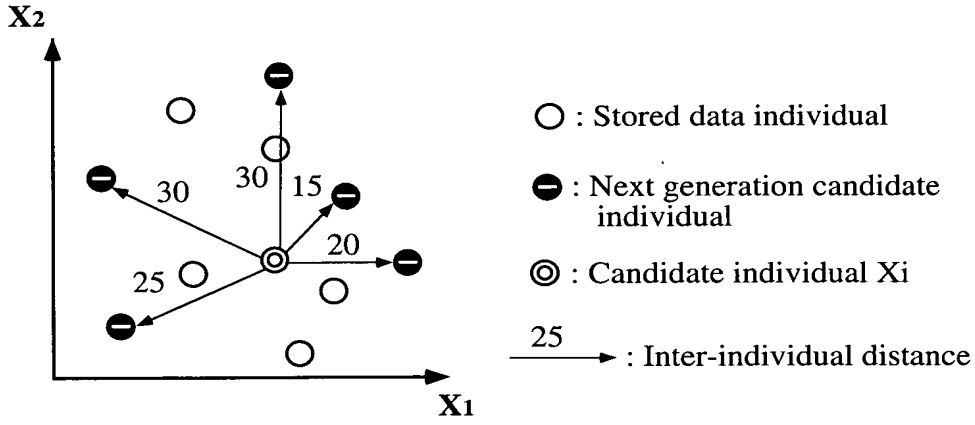
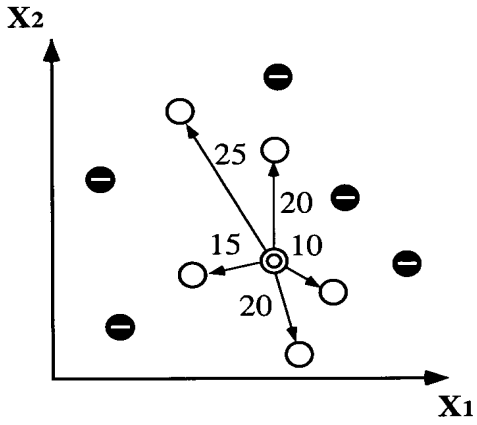


Figure 10(b)



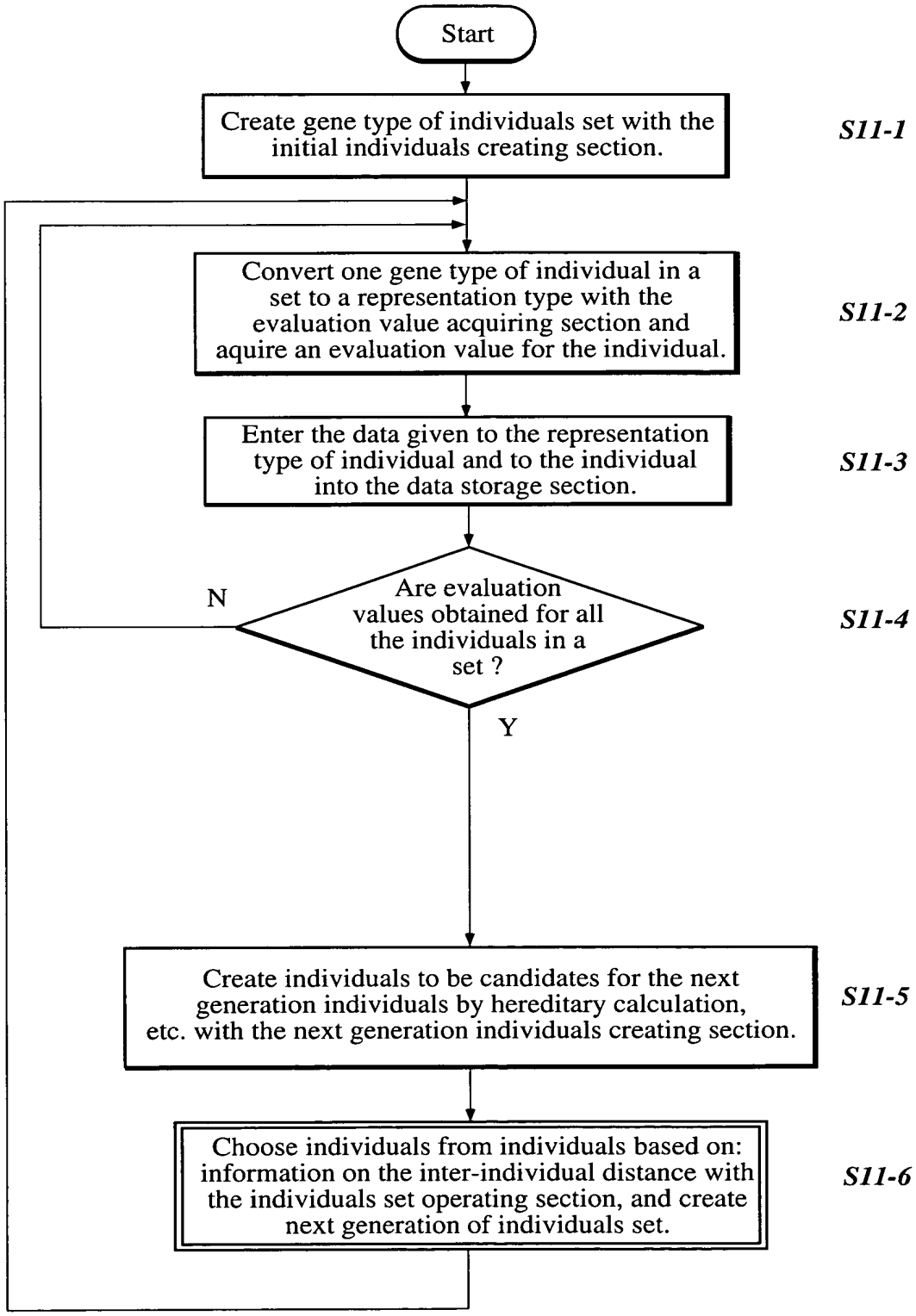

Start
Create gene type of individuals set with the initial individuals creating section.
S11-1
Convert one gene type of individual in a set to a representation type with the evaluation value acquiring section and aquire an evaluation value for the individual.
S11-2
Enter the data given to the representation type of individual and to the individual into the data storage section.
S11-3
Are evaluation values obtained for all the individuals in a set ?
N
Y
S11-4
Create individuals to be candidates for the next generation individuals by hereditary calculation, etc. with the next generation individuals creating section.
S11-5
Choose individuals from individuals based on: information on the inter-individual distance with the individuals set operating section, and create next generation of individuals set.
S11-6

Figure 11

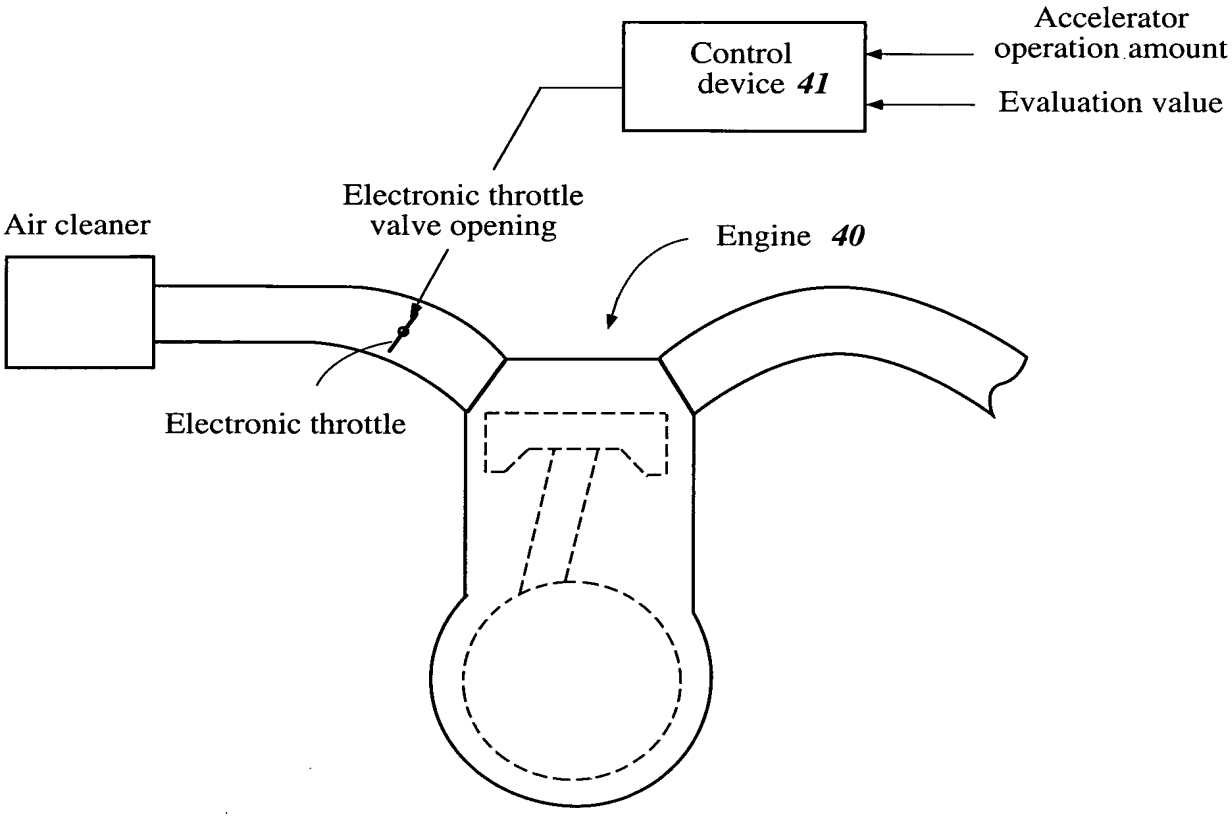

Control
device 41
Accelerator
operation amount
Evaluation value
Electronic throttle
valve opening
Air cleaner
Engine 40
Electronic throttle

Figure 12

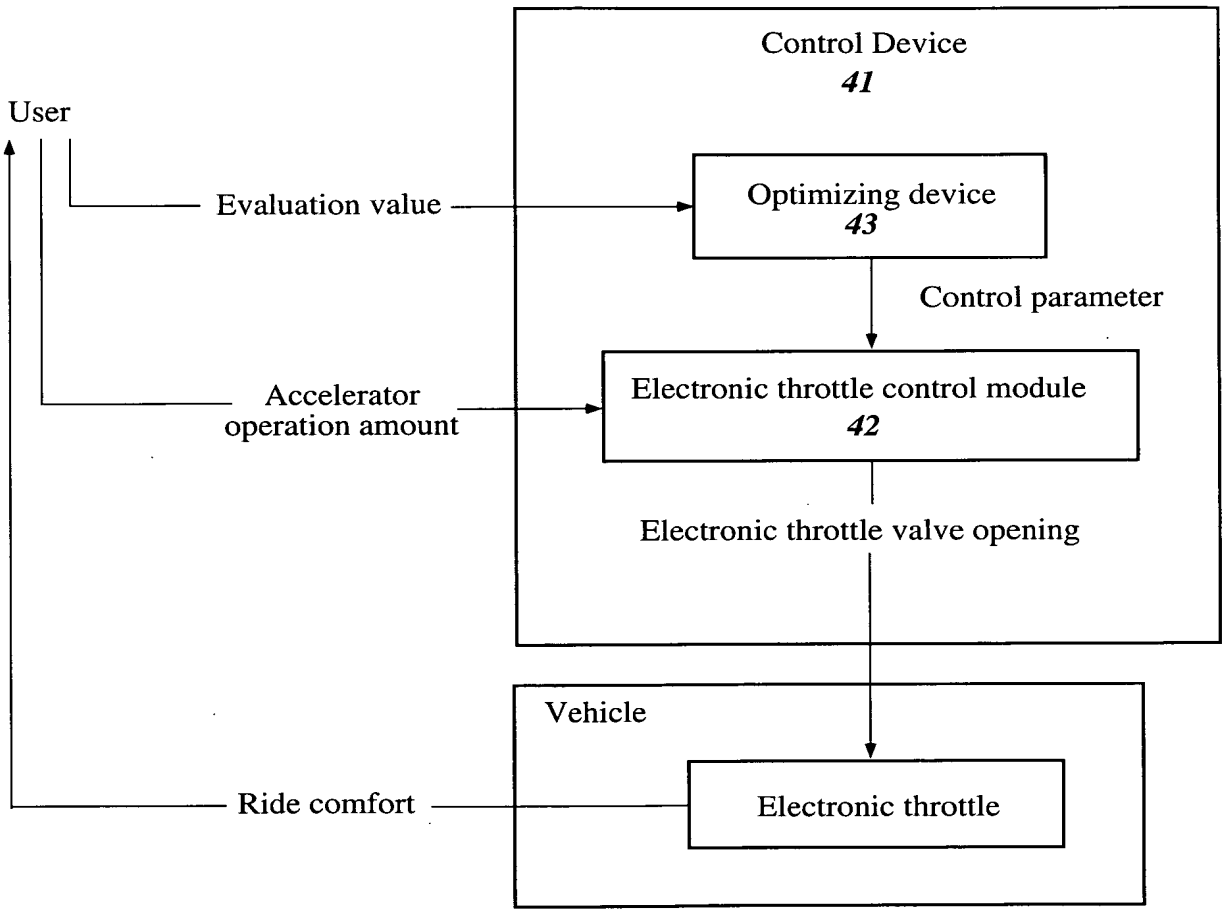
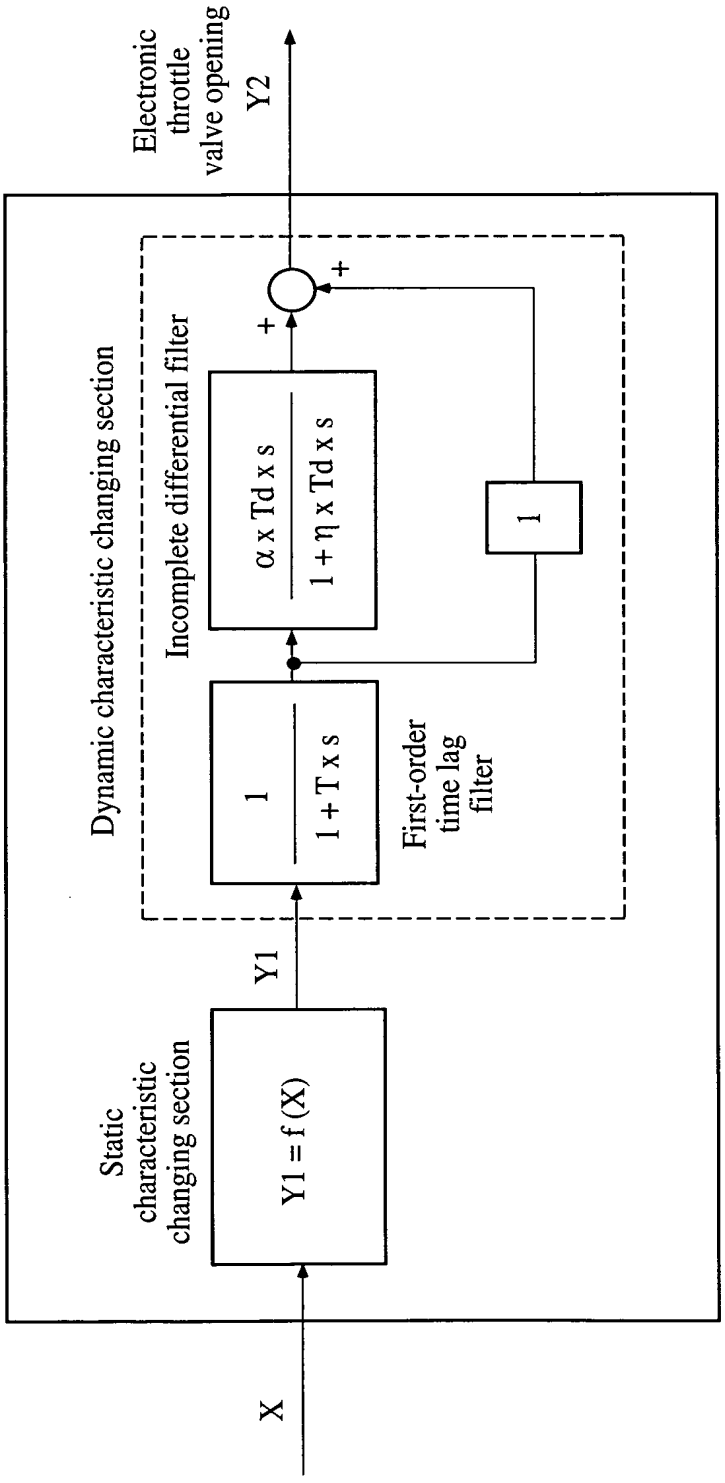

Control Device
41
User
Evaluation value
Optimizing device
43
Control parameter
Accelerator
operation amount
Electronic throttle control module
42
Electronic throttle valve opening
Vehicle
Ride comfort
Electronic throttle

Figure 13



X : Accelerator opening

Y1 : Virtual electronic throttle opening

Y2 : Electronic throttle opening

f : Static characteristic function

T : First-order time lag constant (DR)

Td : Differential time

α : Acceleration compensation factor (AG)

η : Differential gain

Figure 14

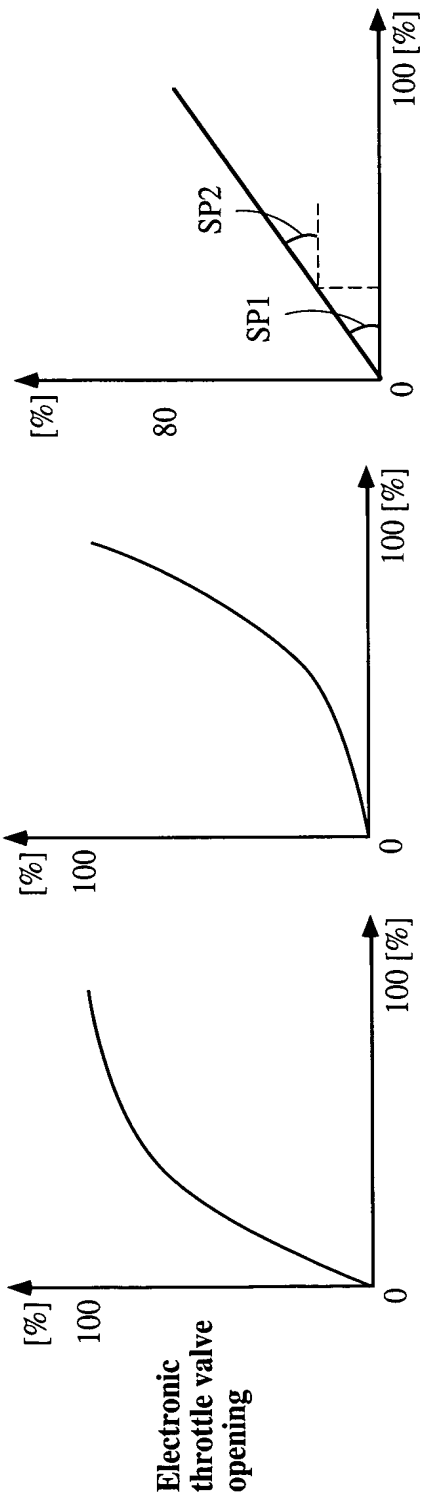


Figure 15(a)

Figure 15(b)

Figure 15(c)

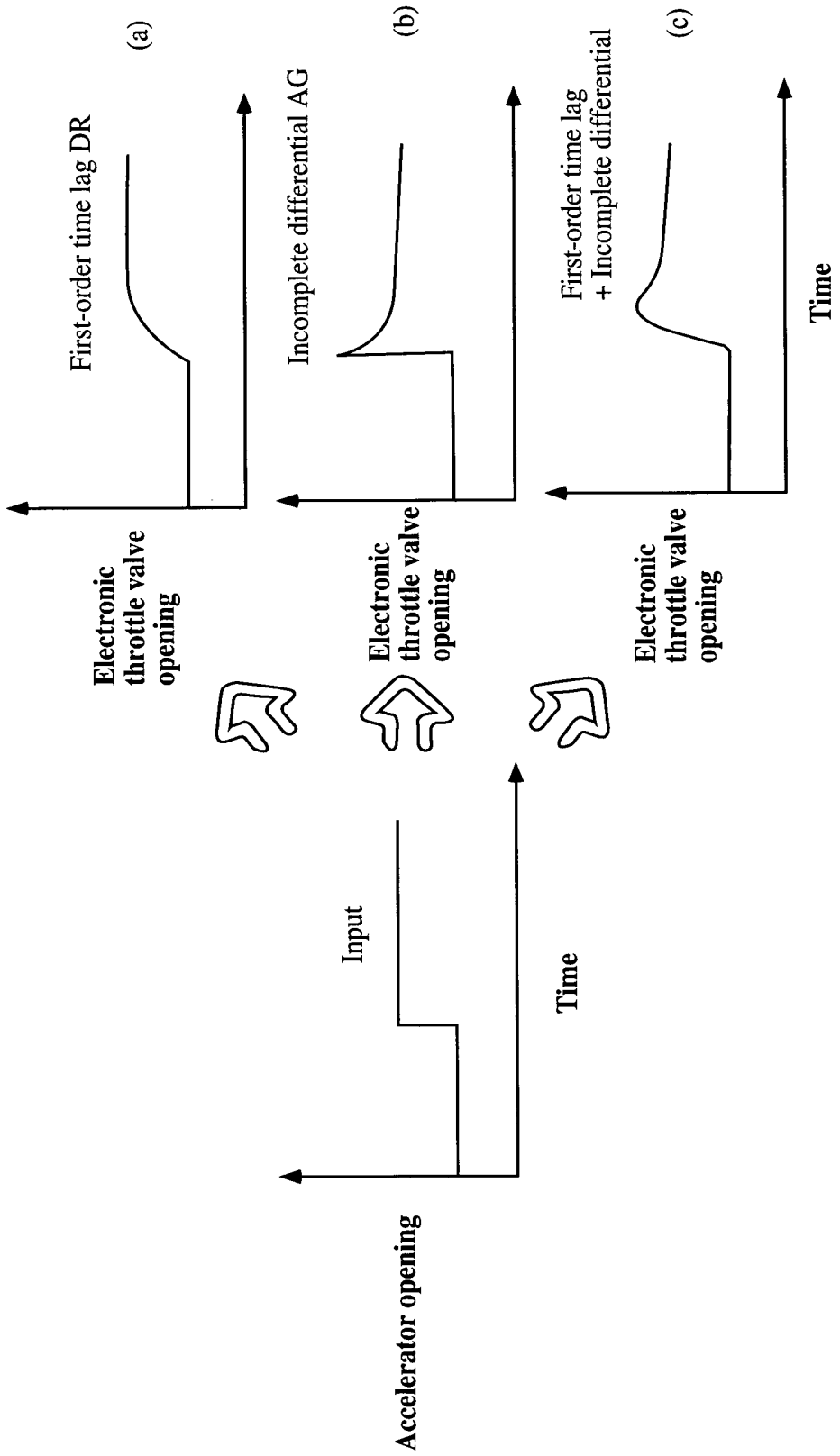

(a)
First-order time lag DR
Electronic throttle valve opening
(b)
Incomplete differential AG
Electronic throttle valve opening
(c)
First-order time lag + Incomplete differential
Electronic throttle valve opening
Time
Input
Time
Accelerator opening

Figure 16

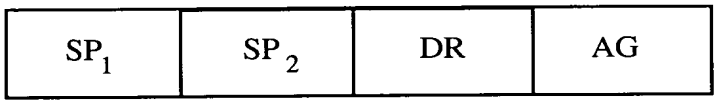


Figure 17

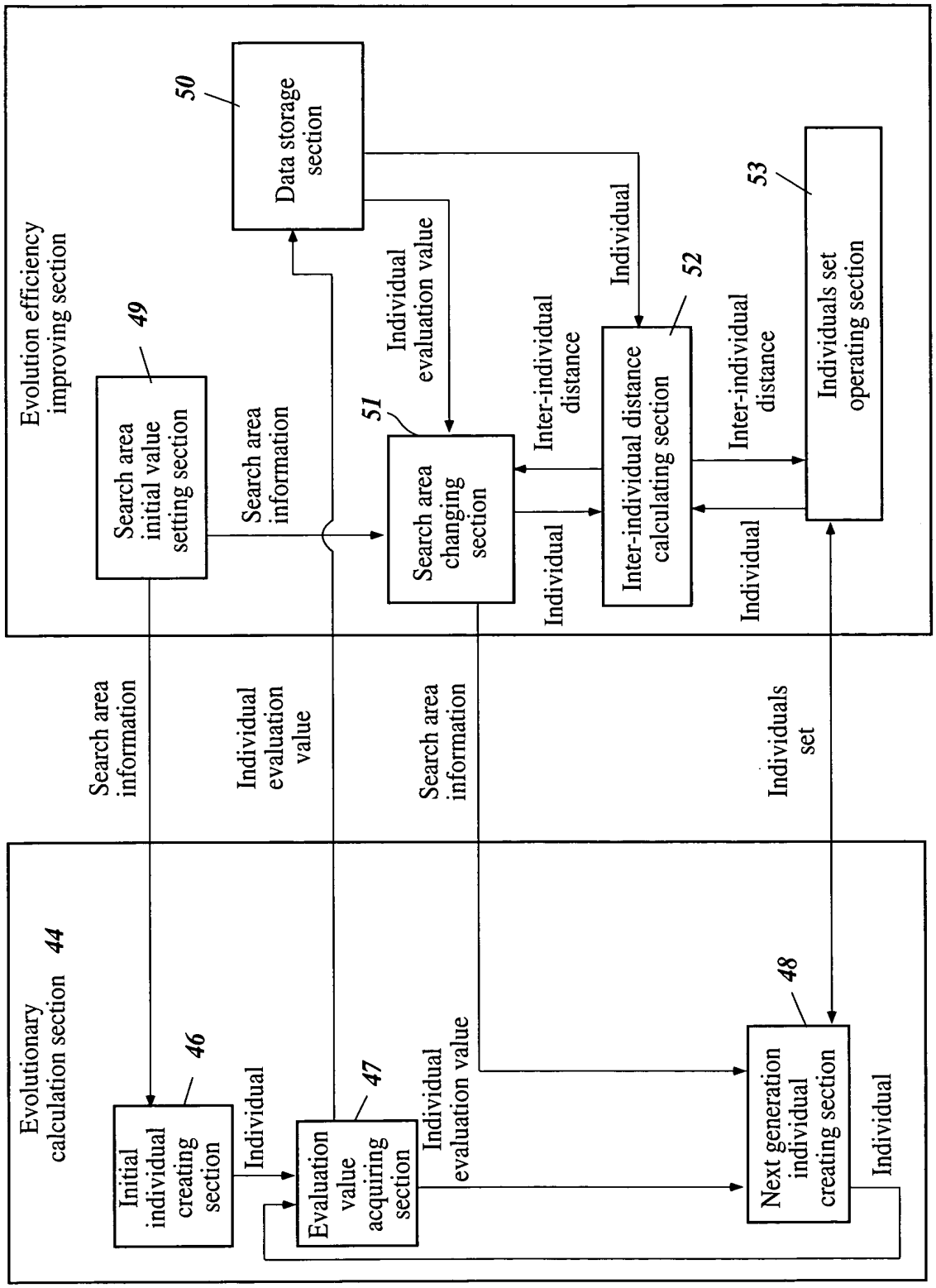

Evolution efficiency improving section
Data storage section
50
Search area initial value setting section
49
Search area information
Individual evaluation value
Search area changing section
51
Inter-individual distance
Individual
Inter-individual distance calculating section
52
Individual
Inter-individual distance
Individuals set operating section
53
Search area information
Individual evaluation value
Search area information
Individuals set
Evolutionary calculation section
44
Initial individual creating section
46
Individual
Evaluation value acquiring section
47
Individual evaluation value
Next generation individual creating section
48
Individual

Figure 18

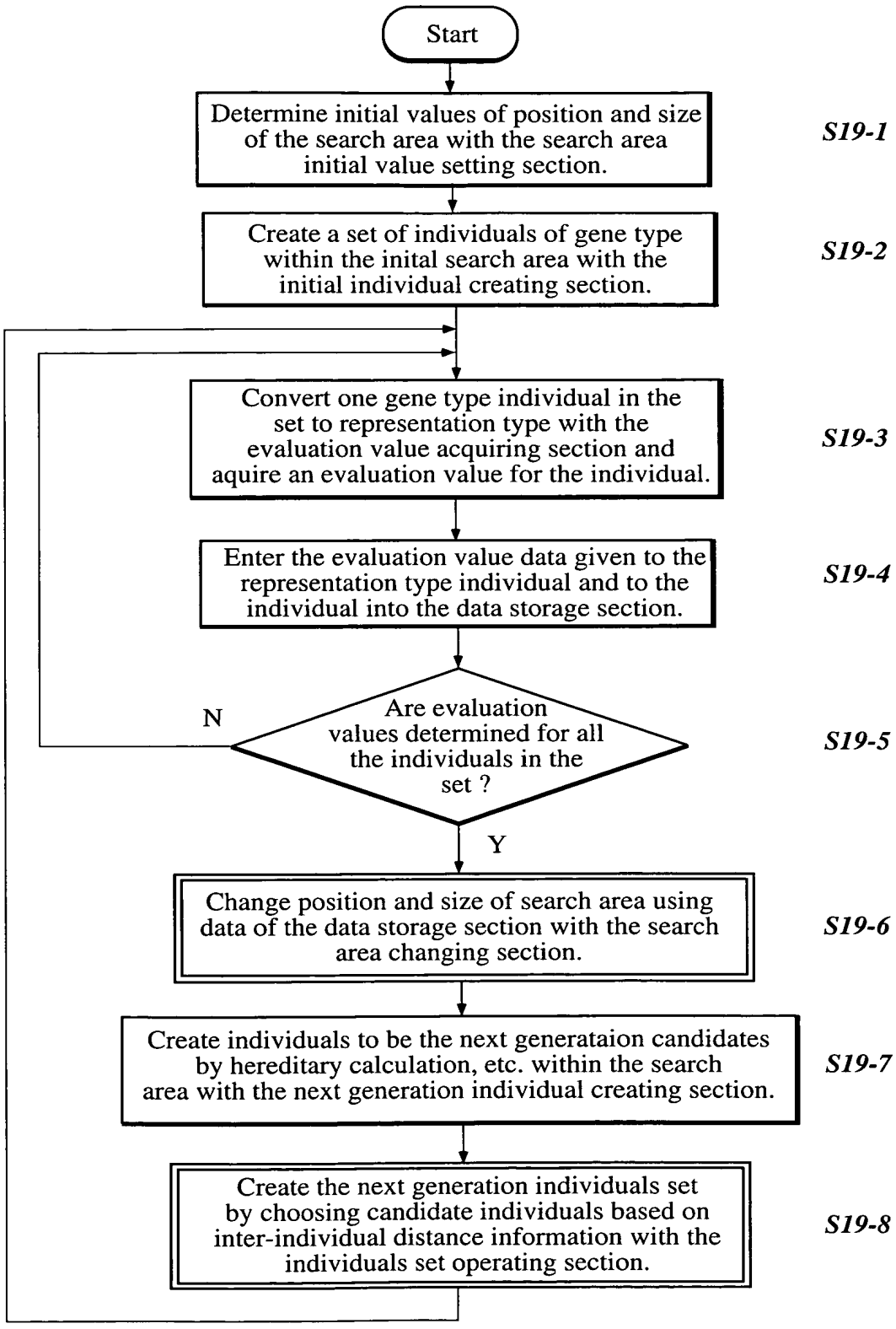

Start
Determine initial values of position and size of the search area with the search area initial value setting section.
S19-1
Create a set of individuals of gene type within the inital search area with the initial individual creating section.
S19-2
Convert one gene type individual in the set to representation type with the evaluation value acquiring section and aquire an evaluation value for the individual.
S19-3
Enter the evaluation value data given to the representation type individual and to the individual into the data storage section.
S19-4
Are evaluation values determined for all the individuals in the set ?
N
Y
S19-5
Change position and size of search area using data of the data storage section with the search area changing section.
S19-6
Create individuals to be the next generataion candidates by hereditary calculation, etc. within the search area with the next generation individual creating section.
S19-7
Create the next generation individuals set by choosing candidate individuals based on inter-individual distance information with the individuals set operating section.
S19-8

Figure 19

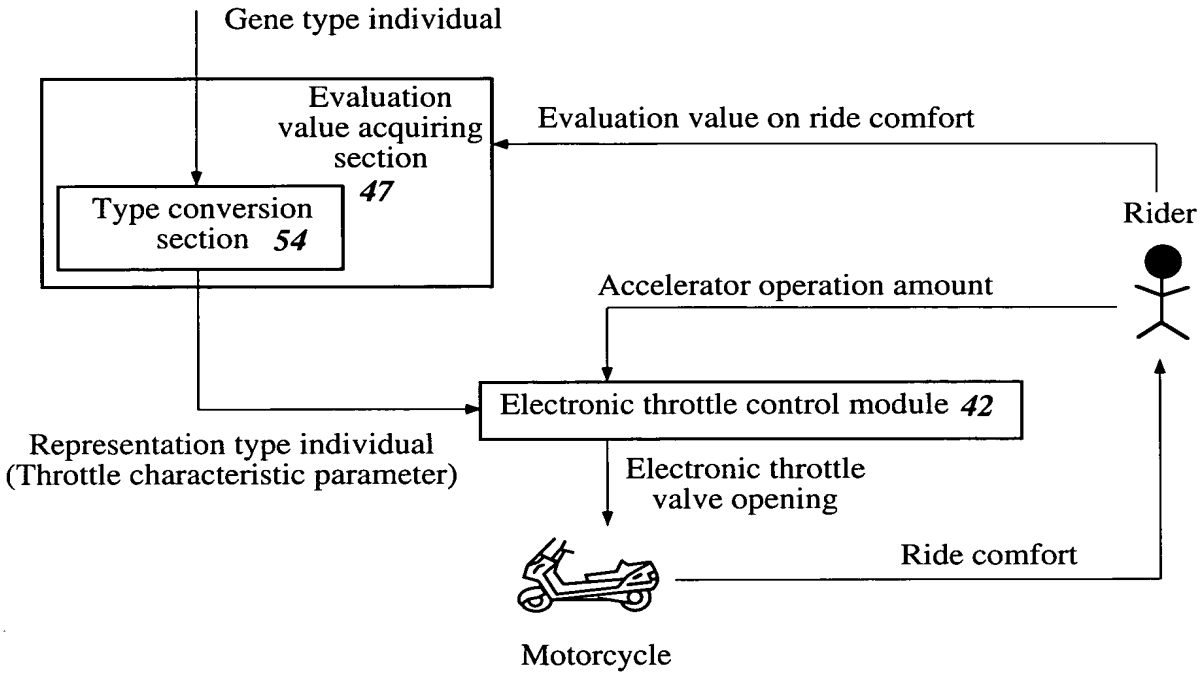

Gene type individual
Evaluation value acquiring section 47
Type conversion section 54
Evaluation value on ride comfort
Rider
Accelerator operation amount
Electronic throttle control module 42
Representation type individual (Throttle characteristic parameter)
Electronic throttle valve opening
Ride comfort
Motorcycle

Figure 20

Figure 21(a)

① : Change by best evaluation value

(Determine irrespective of current search area size)

Best evaluation value Y	Size of next generation search area (Center-to-edge distance)			
	SP1	SP2	DR	AG
$0 \leq Y < 50$	25	25	30	30
$50 \leq Y < 70$	20	20	25	25
$70 \leq Y < 90$	15	15	20	20
$90 \leq Y \leq 100$	10	10	15	15

Figure 21(b)

② : Change by best evaluation value

(Change based on current search area size)

Best evaluation value Y	Search area size (Amount of change in center-to-edge distance)			
	SP1	SP2	DR	AG
$0 \leq Y < 50$	+5	+5	+5	+5
$50 \leq Y < 70$	0	0	0	0
$70 \leq Y < 100$	-5	-5	-5	-5

Create the next generation candidate individuals at constant intervals in all-inclusive manner within the search area.

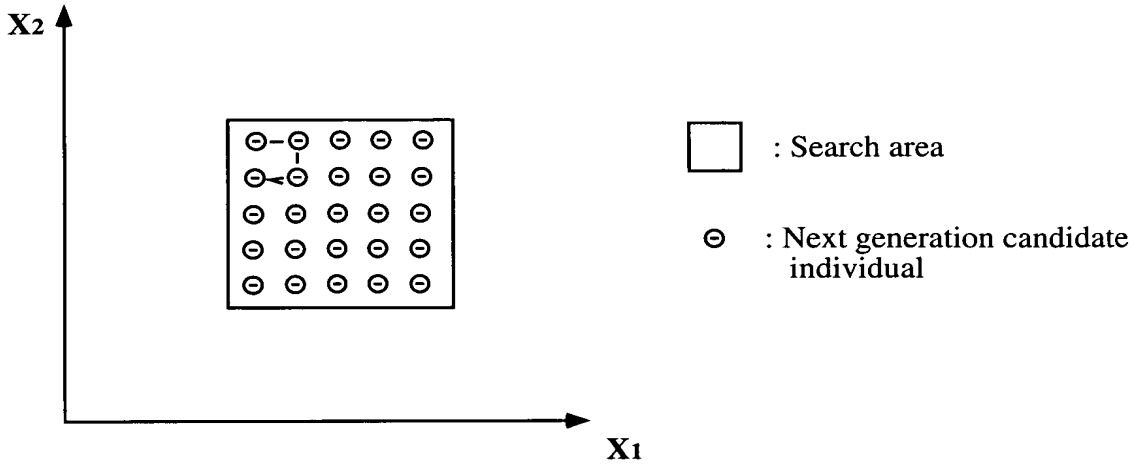


Figure 22

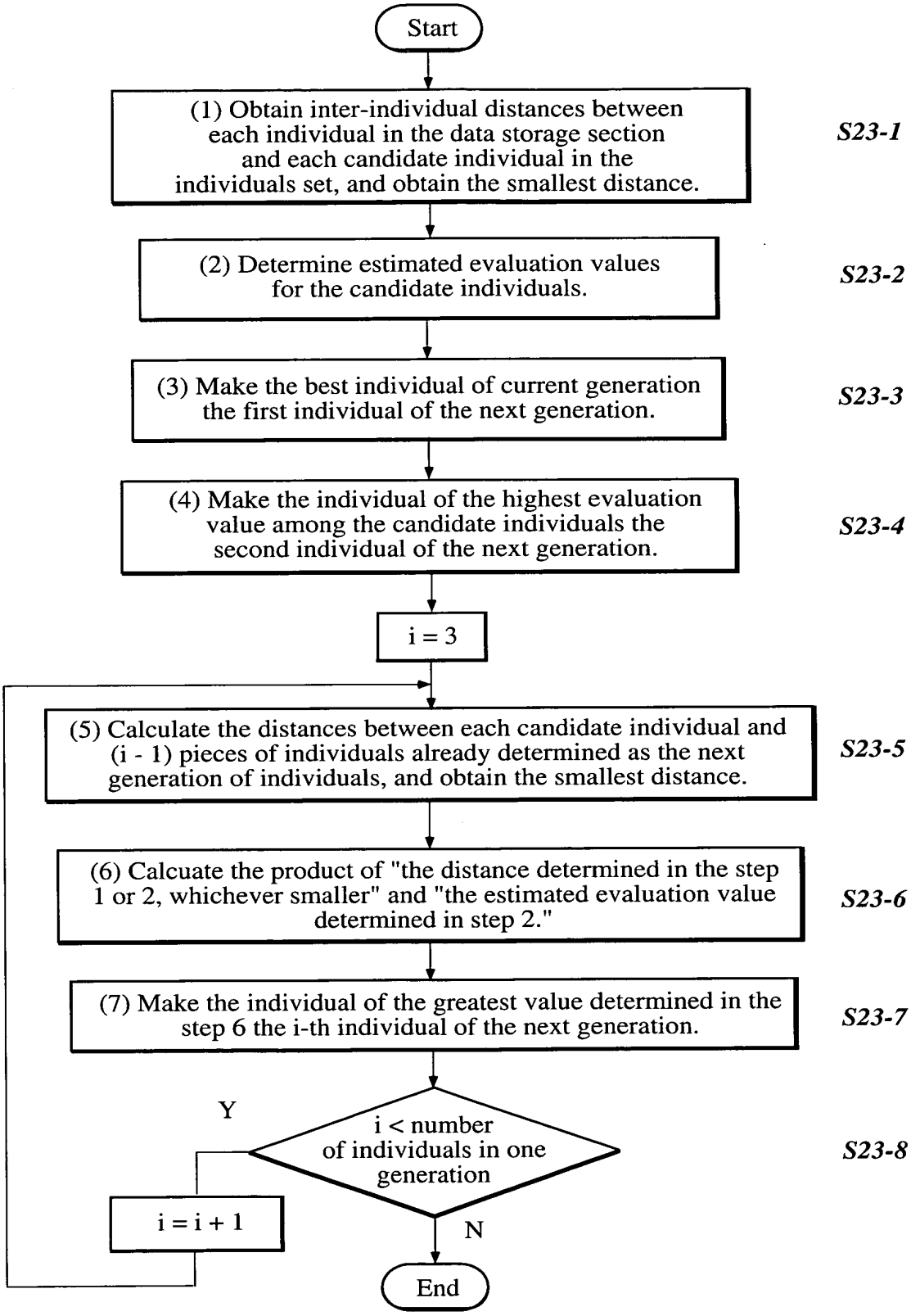

Start
(1) Obtain inter-individual distances between each individual in the data storage section and each candidate individual in the individuals set, and obtain the smallest distance.
S23-1
(2) Determine estimated evaluation values for the candidate individuals.
S23-2
(3) Make the best individual of current generation the first individual of the next generation.
S23-3
(4) Make the individual of the highest evaluation value among the candidate individuals the second individual of the next generation.
S23-4
i = 3
(5) Calculate the distances between each candidate individual and (i - 1) pieces of individuals already determined as the next generation of individuals, and obtain the smallest distance.
S23-5
(6) Calcuate the product of "the distance determined in the step 1 or 2, whichever smaller" and "the estimated evaluation value determined in step 2."
S23-6
(7) Make the individual of the greatest value determined in the step 6 the i-th individual of the next generation.
S23-7
i < number of individuals in one generation
S23-8
Y
N
i = i + 1
End

Figure 23

(60) : Estimated evaluation value

○ : Individuals created so far.
(Individuals in the data storage section)

⊘ : Next generation candidate individuals

● : Individuals chosen for the next generation

25 : Inter-individual distance

Figure 24(a)

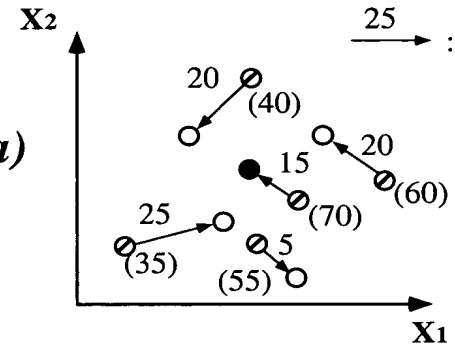


Figure 24(b)

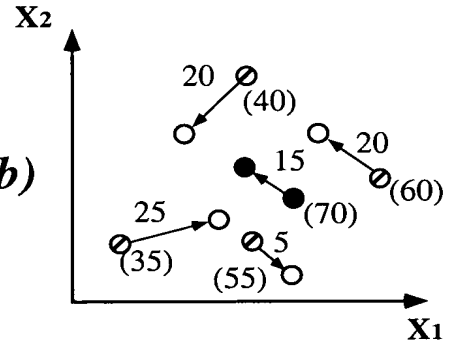


Figure 24(c)